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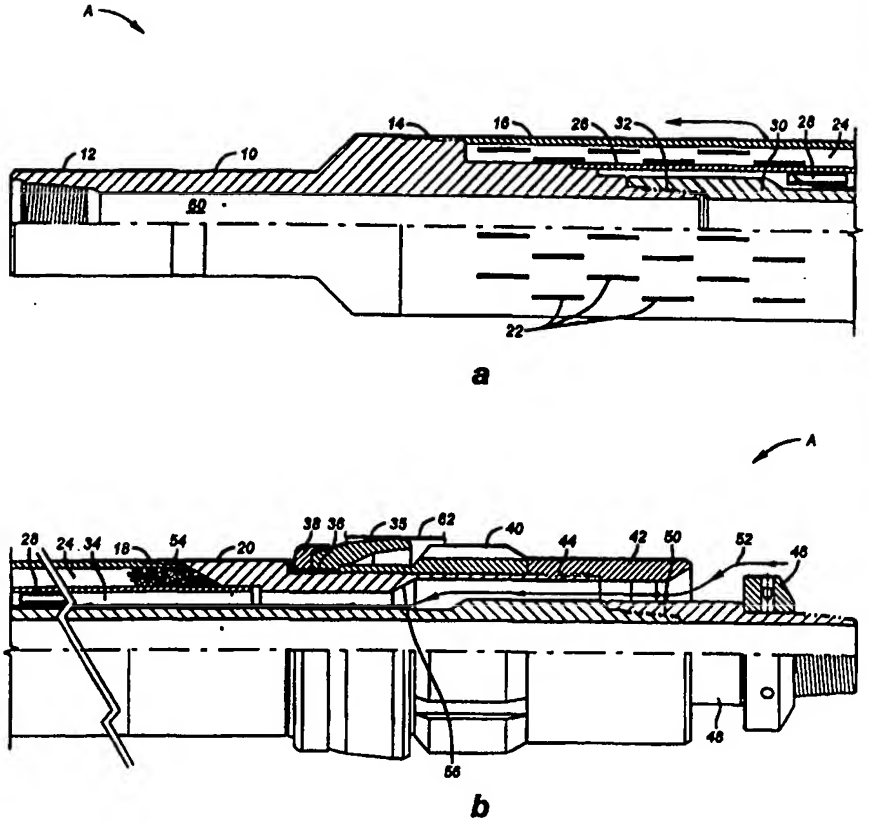
(54) Title: DOWNHOLE CUTTING SEPARATOR

(57) Abstract

A downhole cutting separator is disclosed. The separator can be mounted anywhere on the drillstring. The separator employs a seal (35) which directs the normally circulating fluid during the cutting or milling operation in through an internal passage (60) in the tool. The cutting–laden fluid passes through a slotted liner (16) where the cuttings drop out and are collected in a compartment (24) within the tool. The circulating fluid exits the tool into the annulus. The tools can be used in series so that the lowermost tool takes out the large cuttings, while an upper tool takes out the finer cuttings. Provisions can be made to bypass the tool should it become plugged with cuttings by using rupture discs or movable sleeves responsive to pressure differential. A portion of the body assembly (30) can be magnetic to further assist in removal of cuttings as the circulating flow passes through the tool.



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TITLE: **DOWNHOLE CUTTING SEPARATOR**

FIELD OF THE INVENTION

The field of this invention relates to downhole devices for capturing cuttings from return fluid.

BACKGROUND OF THE INVENTION

When milling metallic objects downhole, cuttings are generated which must be removed from the wellbore. Cuttings that aren't captured near the milling can go uphole and lodge in undesirable places, such as the BOP rams, flow control devices, and pump liners.

In the past, various types of devices have been used to capture cuttings during milling. One such example is a "Boot Basket," product No. 130-16 offered by Baker Oil Tools. This type of tool relies on the sudden decrease in annular velocity when the cuttings pass the larger O.D. of the boot, reaching the smaller O.D. of the body and the top connection. This slowdown in velocity allows some of the flow to come back around into the basket area where the cuttings can be trapped. Similar tools are offered from Red Baron and are called "junk subs." Other designs are called "globe-type junk baskets" offered by Baker Oil Tools, which comprise a hollow milling head and a double set of free-rotating finger catchers, a middle body, and a top sub. In operation, a core is cut from the formation, and any junk that may have obstructed normal drilling should be recovered above the core. This type of design is primarily used in open-hole, due to its inability to produce any reverse circulating action or vacuum. Hydraulic Junk Basket, product No. 130-73, offered by Baker Oil Tools, provides for

movable sleeves which, in turn, rotate a catcher down and under the junk that has accumulated within the body. A similar tool is offered by Houston Engineers Inc. as the H-E Jet Junk Basket. Other types of junk baskets, such as those offered by Bowen, employ reverse circulation. In this type of tool, the flow is directed from inside the tool to the outside, around the bottom, through the junk catcher, and out again through the annular space.

Yet another type of retrieval tool for cuttings is the combination Ball-type Jet and Junk Basket, product No. 130-97, offered by Baker Oil Tools. It uses reverse circulation and coring ability to allow two junk recovery operations in a single run. In the first operation, using high velocity, the tool jet assembly diverts the drilling fluid out of the jet nozzles, down the O.D. of the tool. The fluid goes up through the bottom of the tool and forces any junk items, such as bit cones and hand tools, up into the I.D. of the bushing. The caught debris is held by the catchers attached to the tool. To complete the recovery, the tool is rotated and lowered into the formation to core up any remaining junk. Yet another product offered by Baker Oil Tools is the Jet Bushing, product No. 130-96, which uses high-velocity fluid through the jets to create a vacuum inside the barrel of the tool which causes a reverse circulating effect. The reverse circulation action makes it possible to recover junk without cutting a core. The housing has several junk retention cups so that as the fluid is pumped up the hole, the cups act as internal junk baskets. As fluid passes over these internal projections, the flow velocity is reduced at the top of each projection, causing the loose junk to be released from the fluid stream. Those cuttings which are not removed from the fluid stream are carried up to the jetting assembly and are either flushed uphole or recirculated downhole. Yet another tool in this area is the M Reverse Circulating Tool, offered by Baker Oil Tools. This

tool employs a rubber cup seal that ensures that 100% of the flow going down the drillstring is forced downward on the outside of the junk retrieving pipe. The junk is carried up the inside of the junk retrieving pipe, filtered by a screen, and then the clean fluid is directed out of the tool above the cup. The typical use for this tool is for milling over packers and the milling head is driven by a length of casing rather than drillpipe.

It is an object of the present invention to avoid having to use reverse circulation and, instead, employ through-the-drillpipe circulation to allow the tool to be run with bottom-end tools that have small circulation ports. It is another object of the tool to allow the use of large access ports to efficiently capture the cuttings. This is in distinction to the known designs described above which employed very small ports which limited the ability of the cuttings to enter the cutting retention systems. It is a further object to provide a tool that can be run in any position on the drillstring, as opposed to only on the bottom which is where the prior art designs were located.

Another object of the tool is that it can be run with several of them in series where the first tool removes larger cuttings, and a tool above can remove fine cuttings.

SUMMARY OF THE INVENTION

A downhole cutting separator is disclosed. The separator can be mounted anywhere on the drillstring. The separator employs a seal which directs the normally circulating fluid during the cutting or milling operation in through an internal passage in the tool. The cutting-laden fluid passes through a slotted liner where the cuttings drop out and are collected in a compartment within the tool. The circulating fluid exits the tool into the

annulus. The tools can be used in series so that the lowermost tool takes out the large cuttings, while an upper tool takes out finer cuttings. Provisions can be made to bypass the tool should it become plugged with cuttings by using rupture discs or movable sleeves responsive to pressure differential. A portion of the body assembly can be magnetic to further assist in removal of cuttings as the circulating flow passes through the tool.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1a and 1b are a sectional elevational view of the tool, showing its various components.

Figure 2 illustrates a bypass arrangement if the tool becomes plugged, employing a rupture disc.

Figure 3 illustrates an alternative design to the rupture disc shown in Figure 2, illustrating a movable sleeve as a bypass mechanism for the apparatus.

Figure 4 illustrates the use of a magnetic sub to further assist in capturing cuttings.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The apparatus **A** of the present invention is illustrated in Figures 1a and 1b. A top sub **10** is connected to the drillstring (not shown) at thread **12**. Top sub **10** has an outermost threaded connection **14** to which a slotted liner **16** is secured. Another thread **18** secures the lower end of the slotted liner **16** to the body **20**. The slots **22** are in the upper end of the slotted liner **16**. Slots **22** can take any shape without departing from the spirit of the invention. An annular space **24** is defined between the slotted liner **16** and an inner sleeve **26**. Inner sleeve **26** has a series of openings

28. Openings 28 are shown as slots, but any other shape can be used without departing from the spirit of the invention.

Top sub 10 is connected to body 30 at thread 32. An annular space 34 is defined between the body 30 and the inner sleeve 26. Body 20 has a cup seal 35 which is mounted on a bearing 36. Bearing 36 is retained by top bearing cap assembly 38. To facilitate insertion and assembly, a guide 40 is secured to body 20 below the cup seal 35, and a circulation sub 42 secures the entire assembly to body 20 by connection at thread 44.

A stop ring 46 is connected to a stop sub 48. Stop sub 48 is connected to body 30 at thread 50.

Arrow 52 represents the flow of circulating fluid bearing the cuttings through the apparatus A. The flow represented by arrow 52 enters annular space 34 and eventually passes through openings 28 into annular space 24. At this point, the cuttings 54 drop out to the bottom of annular space 24, while the fluid passes through openings or slots 22. Those skilled in the art will appreciate that multiple assemblies of the apparatus A can be used in series such that the assembly, as shown in Figures 1a and 1b, can have larger openings 22 for the unit installed further downhole, and smaller openings for other units further uphole so as to progressively remove smaller and smaller cuttings. In the event of a release of the slotted liner 16, the stop ring 46 prevents loss of the slotted liner 16 downhole as it prevents downhole movement when contacting the circulation sub 44 or, alternatively, shoulder 56 in body 20. Thread 58 is used to secure the mill.

In operation, the top sub 10 rotates in tandem with body 30 and stop sub 48. The circulating fluid passes through these three members through passage 60 in a normal circulating mode down to the mill (not shown). After exiting the mill, the fluid, laden with cuttings, comes back uphole

through the annular space and its movement is illustrated by arrow **52**. Eventually, the cuttings and fluid pass through openings **28** and into annular space **24**, where the velocity is reduced and the cuttings drop out by gravity and are caught near the bottom of the annular space **24**. The cuttings **54** are ultimately retrieved with the tool. The circulating fluid represented by arrow **52** continues on its path out of annular space **24** through the slots **22** and further uphole, where another apparatus **A** can be mounted as desired. Alternatively, the circulating fluid goes back to the surface, where it is processed in a known manner.

The cup seal **35** remains stationary and in contact with the wellbore, a part of which is shown schematically as **62**. In view of the bearing **36**, the body **20** can rotate under the cup seal **35** in tandem with the drillstring, which includes, in part, top sub **10**, body **30**, and stop sub **48**.

Optional bypass features can be used if the annular space **24** becomes full of cuttings **54**, thus offering backpressure against the flow represented by arrow **52**. As shown in Figure 2, body **20** can have a rupture disc **64** built into an opening **66** in body **20**. The rupture disc **64** is retained by a nut **68** and supported by a washer **70**, with the rupture disc **64** mounted in between. Upon build-up of excessive pressure in annular passage **34**, the rupture disc **64** can break, allowing bypass around annular space **24**.

An alternative design to the bypass arrangement shown in Figure 2 is illustrated in Figure 3. There, a piston **72** normally obstructs a port **74** and is biased to the closed position shown in Figure 3 by a spring **76**. Seals **78** and **80** straddle the opening **74** to retain the sealed relationship so as to direct the flow as represented by arrow **52** in Figures 1a and 1b. However, should sufficient internal pressure develop, the force of spring **76**

is overcome, shifting the piston **72** so that seal **80** passes beyond opening **74** and exposes slots **82** in the piston **72**. At that point, with spring **76** compressed, seal **80** is above opening **74** and seal **84** is below, with openings **82** in between in alignment with passage **74**. Thus, the flow in that condition represented by arrow **52**, will merely exit outlet port **74** and bypass the annular space **24** should it be clogged up with cuttings **54**.

Figure 4 illustrates the use of a magnetic sub **86**, having a magnet **88** located on body **30** so as to be exposed to the annular space **34**. The magnet **88** can take out fine cuttings and can be especially useful when two or more of the apparatuses are used in series, and the large cuttings have already been previously removed.

Those skilled in the art will appreciate the advantage of the design of the present invention. Normal circulation is employed. A seal, such as a cup seal **35** or a suitably acceptable alternative, directs the circulating fluid in the annulus back through an annular space within the tool. Gravity is then employable to allow the captured particles or cuttings **54** to settle in a zone of reduced velocity. A large capture area in the form of annular space **24** is provided since the outlets **22** are at its upper end. In view of the design of the apparatus **A** of the present invention, it can be put anywhere in the string and not necessarily be limited to placement immediately above the mill, as in the past. The apparatus **A** can handle large cuttings and does not require the use of any mechanically operated catch mechanisms to retain the captured cuttings **54**. One or more of the apparatuses can be used in series so that large cuttings are removed first, and smaller cuttings removed further uphole. A bypass feature can be incorporated to allow automatic bypass upon build-up of a certain resistance to flow within the tool. This bypass can be accomplished in a number of different ways,

such as a rupture disc **64** or a movable piston **72**, or other equivalent techniques to open a bypass flowpath from annular space **34**.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

CLAIMS

1. A downhole cutting separator, comprising:

a body having a bore therethrough to accommodate flow downhole;

an outer housing on the body defining a return flowpath up-hole;

a seal on said housing to seal downhole and thereby direct returning fluid with cuttings into said return flowpath;

a retaining device in said return flowpath to capture cuttings and allow return flow uphole.

2. The separator of claim 1, wherein:

said return flowpath comprises a tortuous path to induce the cuttings to drop from the return fluid passing uphole therethrough.

3. The separator of claim 1, wherein:

said seal is rotatably mounted to said outer housing.

4. The separator of claim 1, wherein:

said retaining device comprises a tubular member with a plurality of openings having an uphole and a downhole end.

5. The separator of claim 4, wherein:

said openings are disposed adjacent said uphole end, leaving that portion of said flowpath adjacent said downhole end as a receptacle for dropped cuttings.

6. The separator of claim 5, wherein:
said openings comprise elongated slots.

7. The separator of claim 1, further comprising:
a bypass from said return flowpath through said outer housing, selectively operable on buildup of a predetermined pressure in said return flowpath.

8. The separator of claim 7, wherein:
said bypass comprises a rupture disc.

9. The separator of claim 7, wherein:
said bypass comprises a biased valve element selectively sealingly covering an opening in said outer housing until it is moved by pressure in said return flowpath.

10. The separator of claim 1, further comprising:
a magnetic element in communication with flow in said flow-path to assist in capturing cuttings within said flowpath.

11. The separator of claim 3, wherein:
said seal comprises a cup seal.

12. The separator of claim 2, wherein:
said seal is rotatably mounted to said outer housing.

13. The separator of claim 12, wherein:

said retaining device comprises a tubular member with a plurality of openings having an uphole and a downhole end.

14. The separator of claim 13, wherein:

said openings are disposed adjacent said uphole end, leaving that portion of said flowpath adjacent said downhole end as a receptacle for dropped cuttings.

15. The separator of claim 14, wherein:

said openings comprise elongated slots.

16. The separator of claim 15, further comprising:

a bypass from said return flowpath through said outer housing, selectively operable on buildup of a predetermined pressure in said return flowpath.

17. The separator of claim 16, further comprising:

a magnetic element in communication with flow in said flow-path to assist in capturing cuttings within said flowpath.

18. A downhole cuttings separator system, comprising:

a plurality of bodies, each having a bore therethrough to accommodate flow downhole;

an outer housing on each of said bodies defining a return flowpath uphole on each said body;

a seal on each said outer housing sealing downhole, thereby directing return fluid with cuttings into that portion of said return flowpath in its respective outer housing;

a retaining device in each said outer housing in said return flowpath therein, wherein as said return flow moves uphole through said housings, smaller cuttings are retained successively in said flowpath in said housings on the way uphole.

19. The system of claim 18, wherein:

said seals are rotatably mounted to their respective housings.

20. The system of claim 19, wherein:

said retaining devices comprise tubular members with a plurality of openings, where the openings in each tubular member are bigger than the openings in a corresponding tubular member uphole from it;

each said outer housing comprises a bypass from said return flowpath through said outer housing, selectively operable on buildup of a predetermined pressure in said return flowpath.

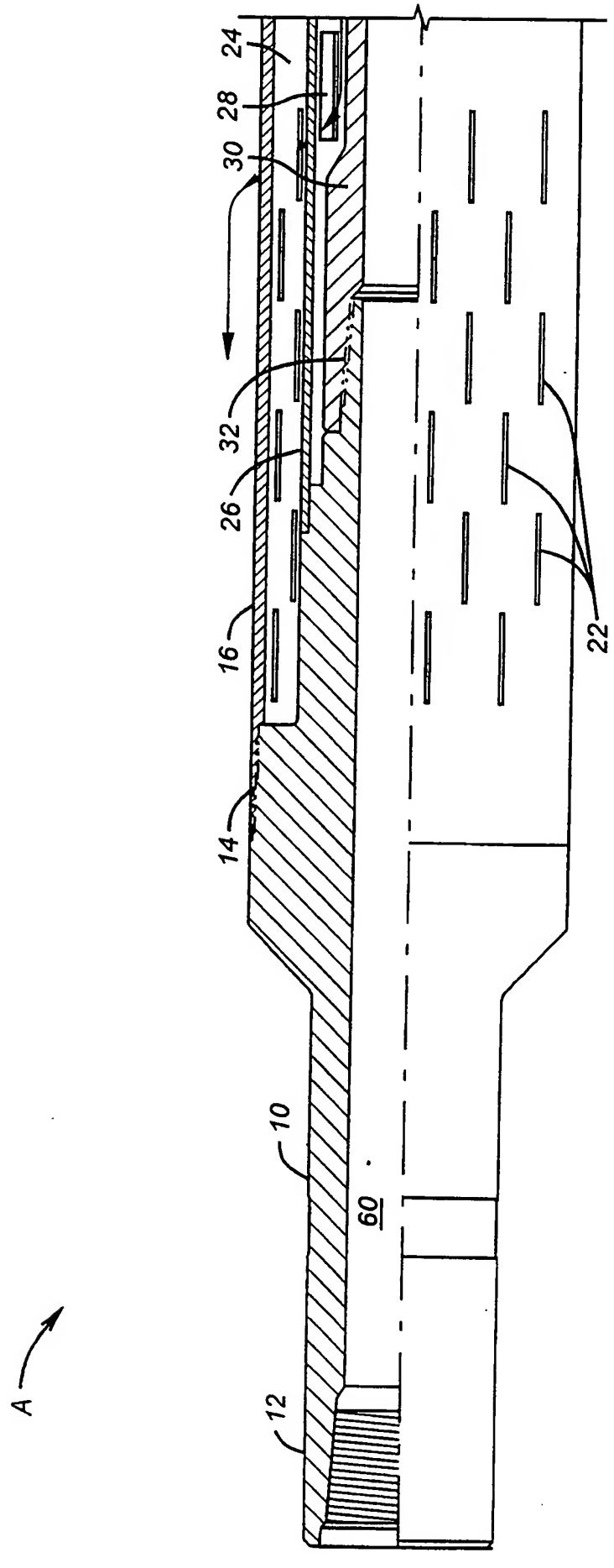

FIG. 1a

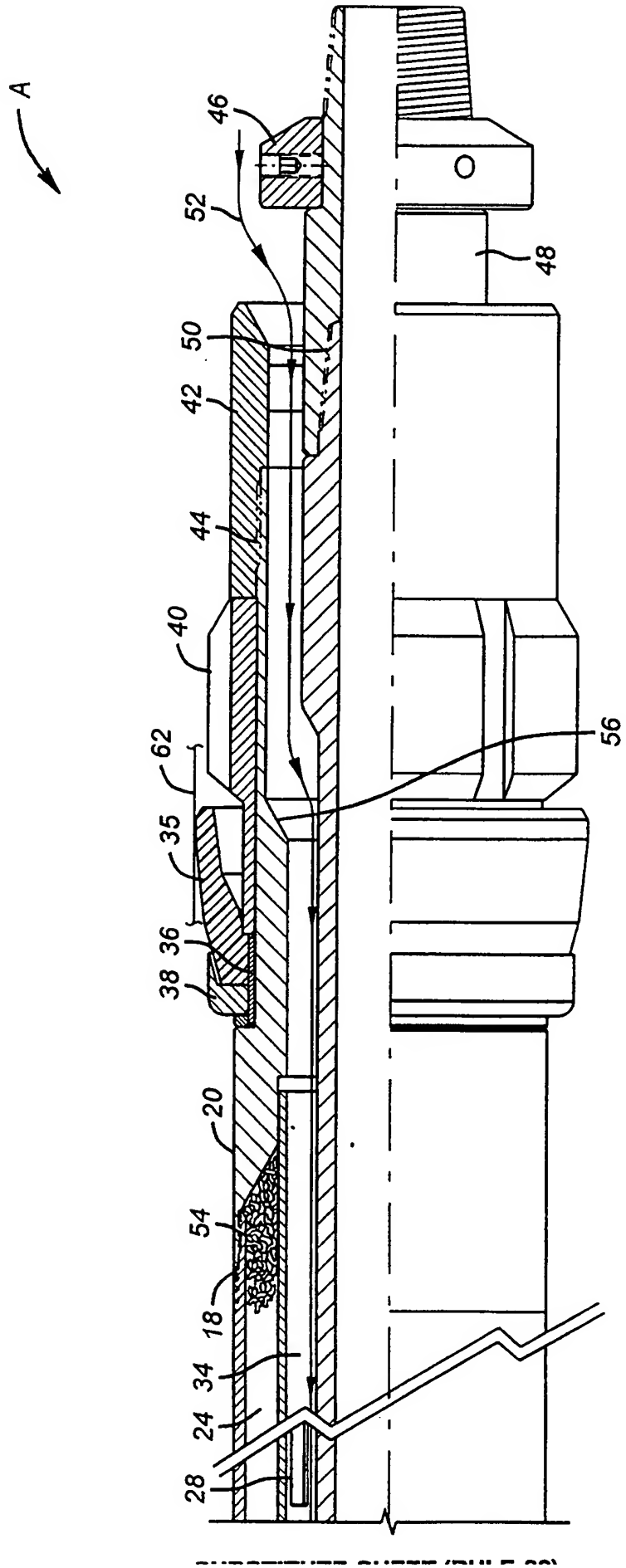

FIG. 1b

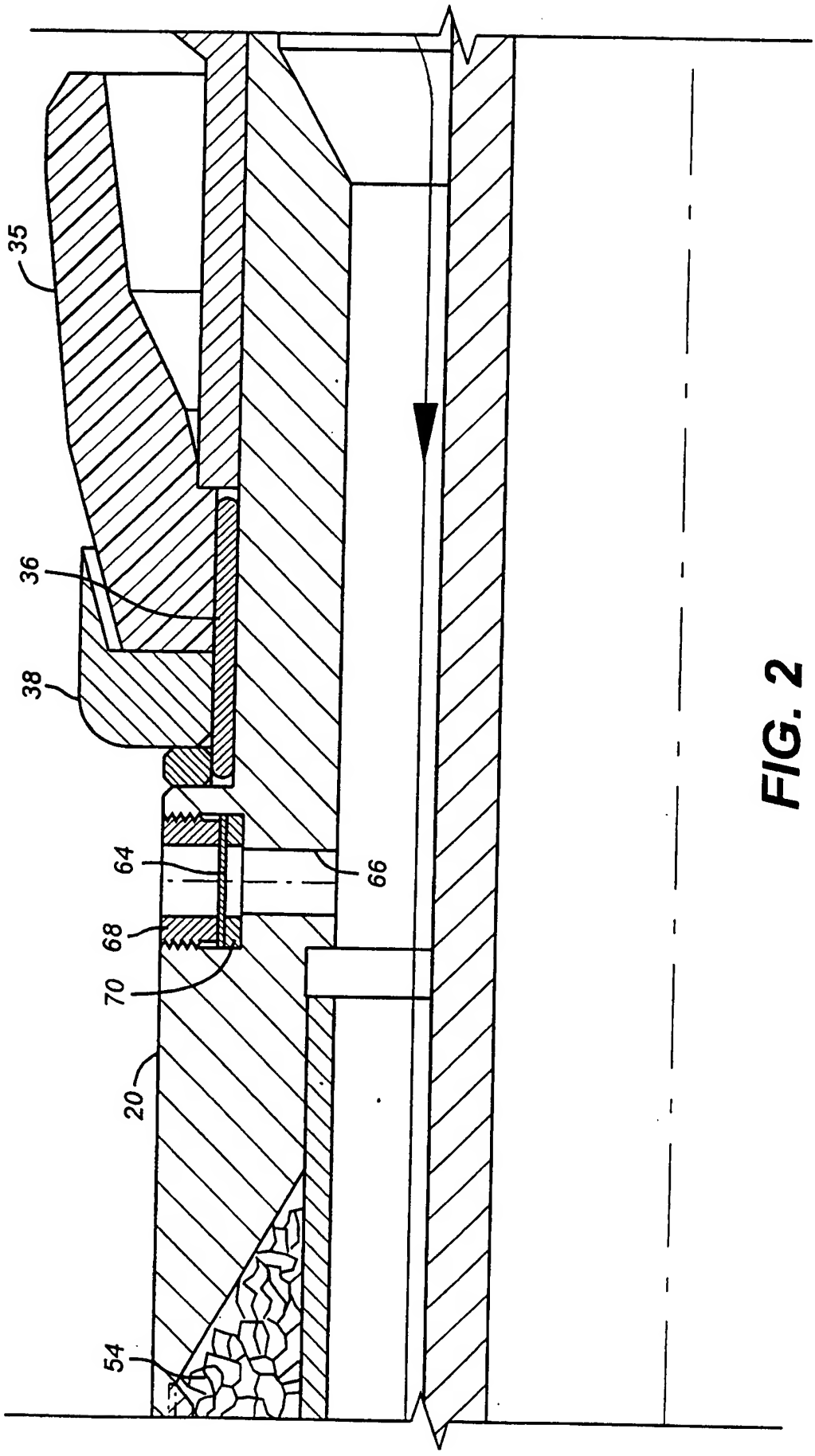

FIG. 2

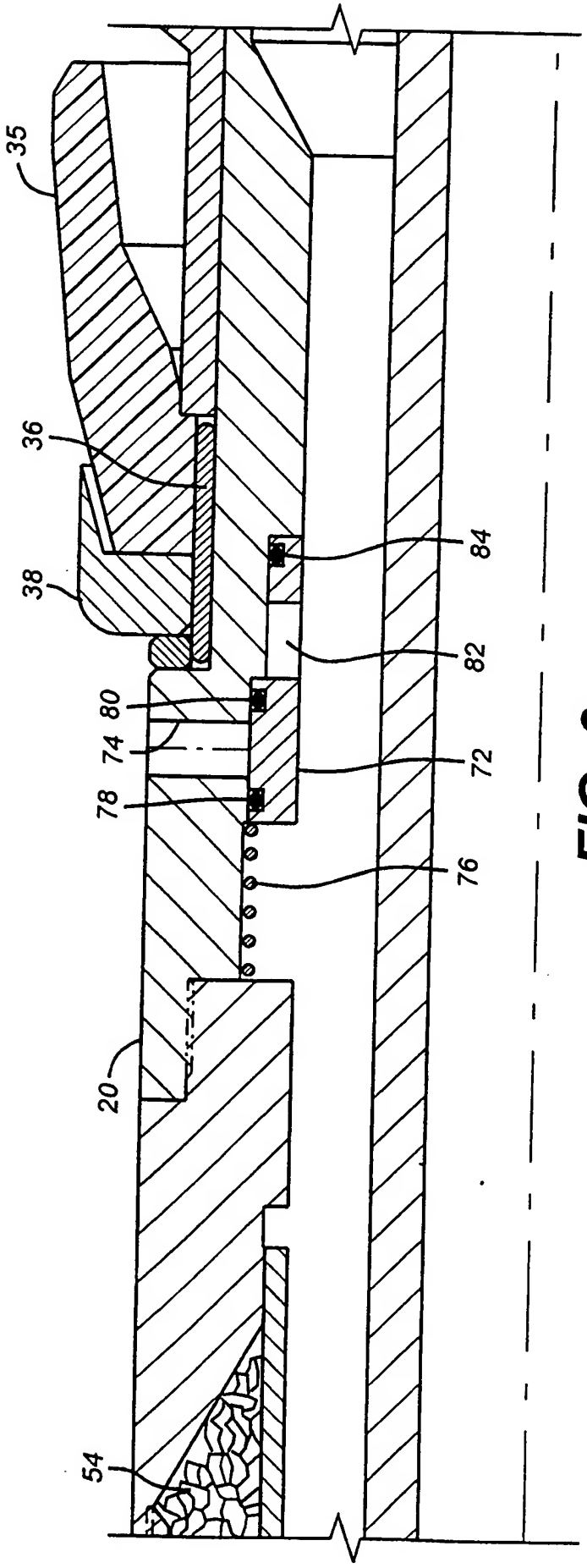

FIG. 3

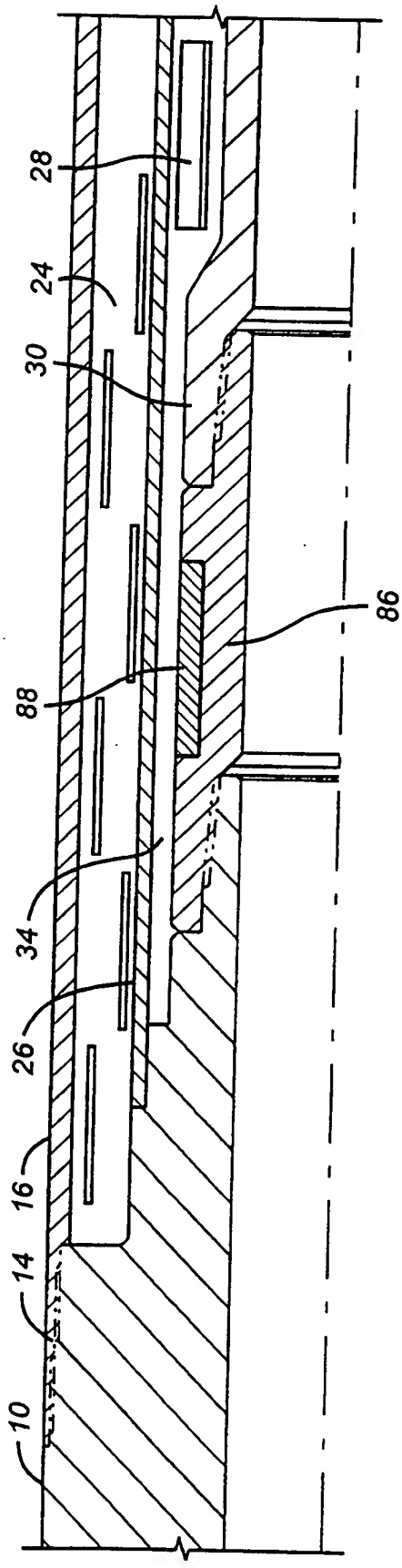

FIG. 4

INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/US 98/22791

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 E21B21/00 E21B27/00 E21B31/08 E21B31/06 E21B21/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 648 788 A (MC KINNEY) 14 March 1972 see column 5, line 6 - line 10 see column 3, line 27 - line 36 ---	1,18
A	US 3 102 600 A (JACKSON) 3 September 1963 see column 2, line 7 - line 36 ---	1,18
A	US 5 176 208 A (LALANDE) 5 January 1993 see column 2, line 43 - line 68 see column 4, line 24 - line 46 ---	1,18
A	US 5 035 291 A (SHIELDS) 30 July 1991 see column 3, line 30 - line 57 see column 4, line 6 - line 10 see column 9, line 61 - line 66 --- -/--	1,18

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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